

For mankind as a whole, a possession infinitely more valuable than individual life is our genetic heritage, our link with past and future. Shaped through long eons of evolution, our genes not only make us what we are, but hold in their minute beings the future—be it one of promise or threat. Yet genetic deterioration through man-made agents is the menace of our time, "the last and greatest danger to our civilization."¹³
(Rachel Carson)

GOAL 3: Strengthen the Information Infrastructure for Toxicology and Environmental Health

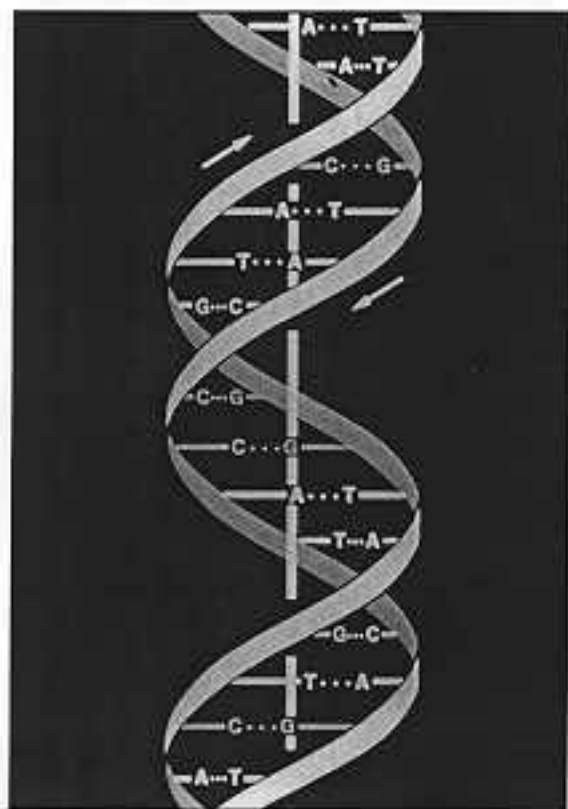
In order for NLM to accomplish the mission set forth in the previous two goals, it is important that certain organizational ("infrastructure") issues be clarified. These involve the importance of NLM positioning itself vis-a-vis future scientific discovery in toxicology and environmental health, the value of providing support to informatics researchers nationwide in these fields, the need to obtain a broader spectrum of advice for NLM information services in toxicology and environmental health, and the advisability of requesting clarification of certain legislative authorities.

3.1 Provide an Information Infrastructure for Future Scientific Discovery in Toxicology and Environmental Health

Future progress in the disciplines that support research and development in toxicology and environmental health is dependent on information resources adequate to their needs. The use of NLM's online services in emergency situations and at the community level is one end of the continuum; at the other is the need of scientists who generate new data and who depend on an ever richer and more sophisticated information environment to support their work. If these are to be mutually reinforcing, the NLM must constantly be alert to sources of new data and to new ways of linking existing data to ensure that what we learn about the environment broadly is turned to maximum use for society.

The Panel believes that a key part of this long-term goal is the development of integrated databases and data handling capabilities that will identify and link the toxic effects of chemical agents to their molecular structures and to the cellular sites of toxic actions.

A recent FCCSET Committee report states that "Biotechnology is a set of powerful tools based on biological knowledge. Mastery of these tools will ultimately touch every facet of American life from the food we eat and the water we drink to the energy that fuels our machines and the materials from which they are constructed. Biotechnology offers novel approaches to conquering disease, easing world hunger, and reducing environmental pollution...The impact



of biotechnology on society and the economy in the coming decade could be profound, and grow dramatically in the next century, if projected technical advances are realized."¹⁴

The rapidly growing body of knowledge about the molecular basis of life is taking the form of computer-based factual databases with explicit links to bibliographic records of the published scientific literature, and implicit links to other factual databases. An example is the GenBank record of nucleic acid sequences of genes (or gene fragments), its links to MEDLINE records of the peer-reviewed publications announcing the discoveries, and its merely implicit links to the records of the amino acid sequences that characterize the protein products of the same gene (see Figure 4).

In addition to such relatively well-known examples, scientists are also reporting the occurrences of molecular changes that may be important "biological markers" for the permanent effects of environmental hazards upon a susceptible population (or individual). By and large, the current design of computer databases does not yet reflect such relationships. NLM should monitor the field and take action so that important scientific data and associations are not obscured within the growing mass of facts.

As more knowledge about the molecular basis of life becomes available, it is important that the molecular and cellular basis of toxicological effects be considered as an organizing principle for future databases. As a starting point, NLM should undertake to analyze current chemical and toxicological data-

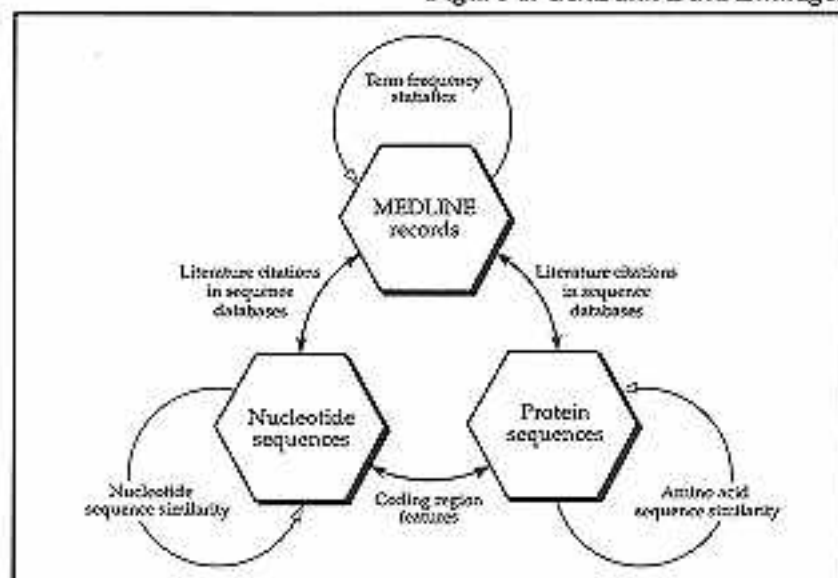
bases with a view to establishing linkages between those and other databases that deal with molecular information, such as genetics, mapping, and sequence databases.

Recommendation 3.1

NLM should investigate possible new information structures and representations that are being used to aid in the understanding of the scientific basis of environmental effects on molecular and cellular systems. When there is sufficient accumulation of data, NLM should specify and design a prototype system for linking chemical and toxicological data with a limited set of molecular databases, concentrating on toxic effects at the molecular and cellular level.

We are on the leading edge of a great wave of research, research that will produce better data and better models, research that will provide regulators with the tools to reduce exposure and protect the public health. There's at least a B-1 bomber's worth of research needs..."¹⁵ (National Research Council)

Figure 4. GenBank Data Linkages



3.2 Initiate Support for Extramural Research in Toxicological and Environmental Health Informatics

With funding and leadership provided by NIH and NLM, a community of researchers has been active for over two decades in wide-ranging applications of computers to medicine. This research has greatly advanced the capabilities of the computer in research and medical decision making and has laid the groundwork for substantial work yet to be done. Specifically, medical informatics research support has resulted in new information management tools, methods for representing the judgment and knowledge of experienced physicians, computer networks to permit efficient communication among health personnel, and expert computer systems to provide advice and decision support to health workers and to monitor health care. The value of such tools will be enhanced progressively as increasingly powerful computer systems and user-friendly interfaces are developed.

There is a need to extend these informatics technologies to areas pertinent to toxicology and environmental health, such as epidemiology, pharmacokinetics, risk assessment, toxic plume dispersion, disaster modeling, and chaos theory. Application of modern informatics technologies is particularly important for new subfields like "molecular toxicology" and "molecular epidemiology." Similarly, there is a need to support research to address pressing needs in the organization and representation of knowledge about toxicology and environmental health. A desirable mechanism to support such research is by extending current NLM grant programs.

Recommendation 3.2

NLM should expand its existing medical and biotechnology informatics research grants program to extend such research into areas that would advance the handling and use of toxicological and environmental health information, and in particular to facilitate research in the field of molecular toxicology.

3.3 Define NLM Responsibilities in Toxicology and Environmental Health

TIP has implemented its products and services in response to major environmental laws that mandate other agencies to provide toxicological and environmental information resources. The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), and its successor legislation, the Superfund Amendments and Reauthorization Act (SARA) of 1986, are cases in point. Although the NLM is not specifically identified in these laws, many of NLM's current activities in toxicology information are now supported under this comprehensive legislation through interagency agreements with Congressionally mandated lead agencies, especially EPA and ATSDR. A graphic representation of the TIP budget over the years is shown in Figure 5.

TIP operates under the authority of the National Library of Medicine Act of 1956 (P.L. 84-941). This Act provides sufficient general legal authority, but does not specifically recognize NLM's activities in the acquisition, organization, and dissemination of information about toxicology and health effects of the

environment. It may be desirable for the NLM Act to acknowledge NLM's roles in these areas.

Recommendation 3.3

NLM's authority should be amended to enunciate specifically the Library's continuing and expanding responsibilities in the areas of toxicology and environmental health.

3.4 Obtain Expert Advice on Long Range Management Principles for the Toxicology Information Program

In 1969, NLM began what was to become a long-lasting relationship with the National Academy of Sciences with the establishment of an advisory committee—the Toxicology Information Program Committee (TIPCOM). Over the years, TIPCOM's membership of illustrious toxicologists, pharmacologists, and chemists, has guided the program. NLM continues to need policy guidance as well as assistance in identifying emerging areas in toxicology and environmental health that may require information support. NLM also needs detailed operational and technical guidance on selecting databases and applying new information technologies.

As described earlier, NLM needs assistance from a users' group to obtain feedback on the technical performance, usability, and acceptability of current database offerings and those under development. If organized under the auspices of TIPCOM—perhaps as a subcommittee—such a group could function as a channel through which

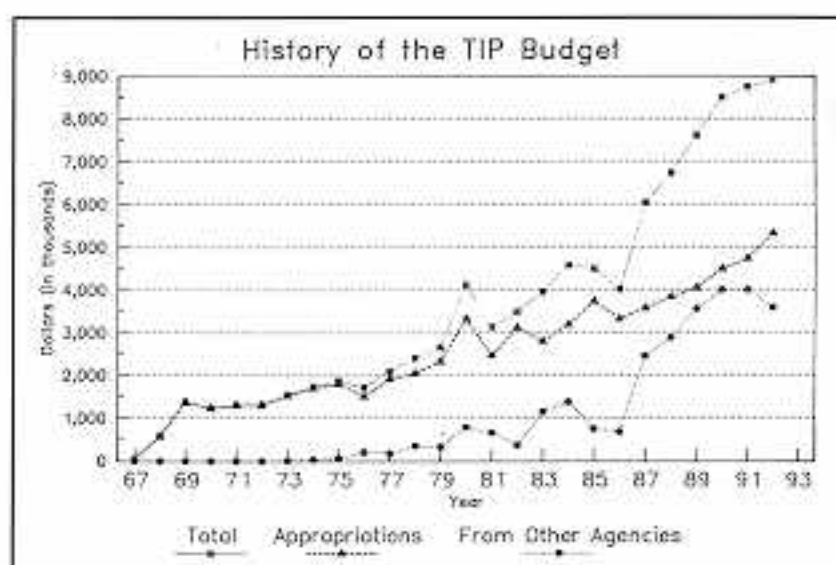


Figure 5

both the TIPCOM membership and NLM management are routinely informed of the user community's needs and expectations. To carry out this expanded charge the current TIPCOM membership would need to be expanded to include representatives of related disciplines (e.g., occupational health, environmental health, computer sciences, database management, and user-system interface development).

Recommendation 3.4

The National Academy of Sciences Toxicology Information Program Committee (TIPCOM) should be expanded in membership and scope of responsibility, and assume a more vigorous role in advising NLM in operational and technical matters, program policy, and new areas of science that should be addressed. A user advisory group comprised of representatives of NLM's enhanced user community should be organized under the auspices of TIPCOM to provide needed feedback on current and anticipated database offerings.